CHEMICAL PRE-TREATMENT ON PALM OIL CLINKER AS PARTIAL CEMENT REPLACEMENT MATERIAL IN MORTAR

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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree in Bachelor of Engineering Technology (Infrastructure Management) with honor

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Malaysia Pahang or any other institutions.

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ABSTRAK

Pengeluaran simen semakin meningkat dari hari ke hari disebabkan perkembangan bandar yang pesat. Permintaan yang tinggi dalam pengeluaran simen mengeluarkan lebih banyak karbon dioksida ke persekitaran yang membawa kepada persekitaran yang tidak sihat. Dalam masa yang sama, kesalahan dalam melupus bahan buangan pepejal berlaku secara berturut-turut telah mengakibatkan pencemaran berlaku. Klinker Minyak Sawit adalah bahan buangan kilang minyak kelapa sawit yang boleh didapati dalam kuantiti yang besar di Malaysia dan ia dianggap sebagai sisa pepejal yang tidak digunakan. Oleh itu, dengan menyalurkan sisa pepejal ke dalam industri pembinaan sebagai bahan pengganti simen dapat membantu mengatasi masalah tersebut. Tujuan kajian ini adalah untuk mengkaji kesan abu klinker minyak sawit yang dirawat dan tidak dirawat ke dalam campuran mortar berdasarkan kekuatan mampatan dan keliangan yang dibandingkan dengan campuran mortar konvensional. Pada dasarnya, proses pra-rawatan kimia dijalankan untuk merangsang reaksi pozzolanic silika amorf dengan kalsium hidroksia dalam mortar. Pra-rawatan abu klinker kelapa sawit dilakukan dengan menggunakan asid hidroklorik yang bertujuan untuk mengeluarkan elemen pelemah yang boleh memberi kesan kepada kekuatan dan kemampatan mortar di samping membantu mengekstrak silika dari abu klinker. Abu klinker kelapa sawit kemudiannya dicampur bersama 0.1 M asid hidroklorik selama 1 jam sebelum ia dikeringkan dalam oven bagi menghasilkan abu klinker yang dirawat untuk bahan gantian simen. Mortar dicampur dan dibancuh dalam 50 mm x 50 mm x 50 mm acuan dan dibiarkan selama 24 jam untuk proses pengerasan. Spesimen direndam di dalam air selama 3, 7, 28 dan 56 hari berturut-turut sebelum dibawa keluar untuk ujian kekuatan mampatan dan ujian keliangan. Keputusan menunjukkan bahawa pada peringkat awal, tindak balas pozzolana untuk T5, T10 dan T15 lebih cepat berbanding spesimen kawalan. Reaksi mula perlahan pada hari ke-28 hingga hari ke-56 dan menyebabkan kekuatan mampatan maksimum dicapai tertinggi oleh sampel kawalan. Lebih banyak silika amorf yang membentuk ikatan C-S-H pada peringkat awal menjadikan mortar lebih kuat dan lebih padat. Walau bagaimanapun, T5 dan T10 masing-masing dapat mencapai 98% kekuatan daripada spesimen kawalan. Perlu diingatkan bahawa penggunaan POCP mengurangkan kekuatan mampatan pada kadar yang biasa. Data statistik membuktikan bahawa tiada perbezaan ketara dalam kekuatan mampatan spesimen kawalan dan T5 dalam mortar. Selain itu, keputusan pada keliangan menunjukkan bahawa peningkatan jumlah POCP ke dalam campuran mortar telah mengurangkan penyerapan air ke dalam mortar akibat tindak balas pozzolana yang berlaku melalui pembentukan gel C-S-H. Penggantian peratusan tinggi POCP tidak dapat membentuk mortar yang lebih kuat kerana struktur berliang yang mengakibatkan ikatan yang lemah di antara zarah abu klinker dan zarah simen. Akhir sekali, penyelidikan ini menunjukkan bahawa POC boleh digunakan sebagai bahan pengganti simen kerana ia merupakan bahan yang sangat bermanfaat yang memberi sumbangan besar kepada persekitaran dan pembangunan mampan. Kesimpulannya, dengan menggunakan 0.1 M asid hidroklorik pada tempoh 1 jam untuk proses pra-rawatan, penggantian yang paling optimum dicapai oleh T5 kerana keupayaannya dalam menghasilkan 98% kekuatan mampatan daripada sampel kawalan dan juga dengan kurangnya liang dalam mortar.

ABSTRACT

The production of cement is increasing day by day due to the rapid urban expansion. Highly demands in cement production emits more carbon dioxide to the environment thus leads to the unsustainable environment. At that time, improper disposal of solid waste materials results on the pollution to occur consecutively. Palm Oil Clinker (POC) is a by-product of palm oil mill which can be found in large quantity in Malaysia and it is considered as waste. Hence, by channelling the solid waste into the construction industry as cement replacement materials helps to overcome those problems. The aim of this research is to study the effects of treated and untreated palm oil clinker ash into the mortar mixture based on the compressive strength and porosity comparing to that conventional mortar mixture. Basically, chemical pre-treatment process is conducted to stimulate the pozzolanic reaction of amorphous silica with calcium hydroxide in the mortar. The pre-treatment of palm oil clinker ash is conducted by using hydrochloric acid (HCl) which purposely to remove heavy metals that present in the ash beside helps in extracting a high amount of silica from the ash. The ash was then impregnated in the dilution of 0.1 M hydrochloric acid for 1 hour before it was dried in oven forming treated ash for the cement replacement material. POCP were studied at various replacement levels of treated and untreated POCP at 5%, 10% and 15% of the original total weight of the Ordinary Portland cement respectively. The mortar was mixed and cast in 50 mm x 50 mm x 50 mm mould and left 24 hours for the hardening process. The specimens are demoulded and left cured for 3, 7, 28 and 56 days consecutively before it was taken out for the compressive strength and porosity testing. The results indicate that at the early stages, the pozzolanic reaction for T5, T10 and T15 is faster than the control specimen thus resulting in higher compressive strength. The reaction starts to slow down at day 28 up to day 56 causing the maximum compressive strength attained the highest by the control samples. More amorphous silica forming the additional calcium-silicate-hydrate (C-S-H) bond at the early days making the mortar stronger and denser. However, T5 and T10 able to gain 98% of the control specimen strength respectively. It should be noted that the use of POCP reduced the compressive strength at a remarkable rate. The statistical data proved that there was no significant difference in compressive strength of the control specimen and T5 in the mortar. While the results on porosity show that increase in the amount of POCP into the mortar mixture had reduced the water usage into the mortar due to the pozzolanic reaction that took place through the formation of C-S-H gel. Replacement of high percentage of POCP unable to form a stronger mortar due to a porous structure that results in poor interlocking bond and poor blending properties between ash particles and cement particles. Last but not least, this research reveals that the POC can be used as cement replacement materials as it is a highly beneficial material contributing substantially toward the sustainable environment and development. To conclude, by using 0.1 M of hydrochloric acid at 1-hour duration for pre-treatment process, the most optimum proportion is attained by T5 because of its ability to produce 98% of control samples' compressive strength and also with the presence of fewer voids in the mortar.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
BS	British Standard
C-S-H	Calcium Silicate Hydrate
D	dry mass
EFB	Empty Fruit Bunches
FA	Fly Ash
FTIR	Fourier Transform Infrared Spectroscopy
HCl	Hydrochloric Acid
M	saturated mass
MF	Mesocarp Fibre
OPC	Ordinary Portland Cement
OPT	Oil Palm Trunk
OPL	Oil Palm Leaves
OPF	Oil Palm Frond
POC	Palm Oil Clinker
POCP	Palm Oil Clinker Powder
POFA	Palm Oil Fuel Ash
PKS	Palm Kernel Shell
P	porosity
RHA	Rice Husk Ash
rpm	rotation per minutes
SBGA	Sugarcane Bagasse Ash

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